

**WHAT IS CLAIMED IS:**

1     1. A polymer electrolyte membrane comprising a quaternized  
2     amine salt on a support matrix.

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4     2. The polymer electrolyte membrane of claim 1, further  
5     comprising a fuel cell comprising an anode and a cathode,  
6     wherein said fuel cell is a liquid-feed fuel cell and wherein  
7     the polymer electrolyte membrane is disposed between the anode  
8     and cathode.

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10    3. The polymer electrolyte membrane of claim 2, wherein said  
11    fuel cell is a direct methanol fuel cell.

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13    4. The polymer electrolyte membrane of claim 1, wherein the  
14    quaternized amine salt is selected from the group consisting  
15    of a poly-4-vinylpyridinebisulfate, a poly-4-  
16    vinylpyridinebisulfate silica composite, and a combination  
17    thereof.

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19    5. The polymer electrolyte membrane of claim 1, wherein the  
20    support matrix is selected from the group consisting of a  
21    glass fiber matrix, a polybenzoxazole matrix, and a  
22    polybenzimidazole matrix.

23

24    6. A methanol fuel cell comprising:  
25    an anode;  
26    a cathode;  
27    a proton-conducting membrane comprising a quaternized amine  
28    salt on a support matrix; and  
29    a pump element, in fluid communication with the anode.

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31 7. The fuel cell of claim 6, wherein the fuel cell uses  
32 methanol.

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34 8. The fuel cell of claim 6, which is a direct methanol fuel  
35 cell.

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37 9. The fuel cell of claim 6, wherein the quaternized amine  
38 salt is selected from the group consisting of a poly-4-  
39 vinylpyridinebisulfate, a poly-4-vinylpyridinebisulfate silica  
40 composite, and a combination thereof.

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42 10. The fuel cell of claim 6, wherein the support matrix is  
43 selected from the group consisting of a glass fiber matrix, a  
44 polybenzoxazole matrix, and a polybenzimidazole matrix.

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46 11. A proton conducting membrane comprising a quaternized  
47 polyvinylpyridine polymer or composite.

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49 12. The proton conducting membrane of claim 11, wherein the  
50 composite comprises a nanoparticulate oxide.

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52 13. The proton conducting membrane of claim 12, wherein the  
53 composite is a poly-4-vinylpyridine bisulfate silica.

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55 14. The proton conducting membrane of claim 11, wherein the  
56 quaternized polyvinylpyridine is poly-4-vinylpyridine  
57 bisulfate.

58  
59 15. A method of forming a proton conducting membrane  
60 comprising  
61 dissolving poly-4-vinylpyridine in a solvent to form a  
62 mixture;

63                   contacting the mixture with sulfuric acid or phosphoric  
64                   acid to obtain a precipitate;  
65                   recovering the precipitate;  
66                   mixing the precipitate with an aqueous solvent to form a  
67                   paste; and  
68                   applying the paste to a support matrix.

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70       16. The method of claim 15, wherein the solvent is methanol.

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72       17. The method of claim 15, wherein the precipitate is a  
73                   poly-4-vinylpyridine bisulfate.

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75       18. The method of claim 15, wherein the aqueous solvent is  
76                   water.

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78       19. The method of claim 15, wherein the support matrix is  
79                   selected from the group consisting of a glass fiber matrix, a  
80                   polybenzoxazole matrix, and a polybenzimidazole matrix.

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82       20. The method of claim 15, further comprising adding  
83                   nanoparticle silica to the mixture prior to adding the acid.

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85       21. The method of claim 20, wherein the precipitate is a  
86                   poly-4-vinylpyridine bisulfate silica.

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88       22. The method of claim 20, wherein the silica is rich in  
89                   surface hydroxyl groups.